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## **Federal Aviation Administration National Airspace System Capital Investment Plan for Fiscal Years 2005–2009**

### **1 Introduction**

#### **1.1 What Is the Capital Investment Plan?**

The Federal Aviation Administration (FAA) Capital Investment Plan (CIP) is a five-year financial plan that allocates funding to National Airspace System (NAS) projects. It is based on a detailed analysis of project funding by FAA functional working groups. It is developed consistent with the technical planning in the NAS Architecture. The CIP includes estimates for the current fiscal year budget and for each of the next four years' expenditures for each line item in the Facilities and Equipment budget. It provides a clear understanding of how much modernization we can do in that five-year timeframe. Consistent with appropriations legislation, the total funding estimates in the CIP equal the Office of Management and Budget's (OMB) estimates for the same timeframe.

In developing the CIP, we analyze our needs for modernization and allocate funding based on how the CIP projects support the FAA strategic goals and performance targets. The five-year plan gives us a broader view of NAS modernization and helps us to:

- Successfully manage projects with a high degree of complexity.
- Focus our investments on strategic goals, such as reducing capacity constraints at the largest airports and improving system efficiency.
- Integrate planning for implementing all the new systems to ensure financial support for interdependent systems.

#### **1.2 The Capital Investment Plan Allocates Funds to Priority Projects**

The CIP's detailed financial plan is essential to the FAA for allocating present and future resources to complete capital investment projects. Because it takes several years to implement many of the projects, we must allocate future-year resources in advance. However, future-year estimates for total FAA capital investment funding are limited to the OMB future year estimates for Facilities and Equipment in the President's Budget. This restriction requires us to choose among modernization alternatives. As a result, the CIP only includes projects that most likely will receive funding and that the FAA can complete. These future-year estimates, in many cases, also provide a financial baseline for individual projects, which we can use to manage these projects against cost and schedule targets.

#### **1.3 The Air Traffic Organization and the CIP**

The FAA has begun the transition of air traffic control and supporting functions to a performance based organization called the Air Traffic Organization (ATO). Over the next couple of years the ATO will put mechanisms in place to reflect its new

## Capital Investment Plan Fiscal Years 2005-2009

management philosophy and structure. Non-air traffic functions such as safety regulation and airport grants will be managed by existing organizations within the FAA. This year's CIP reflects plans developed prior to the transition to the ATO, but it is aligned with the goals, objectives and performance targets contained in the FAA Flight Plan 2004-2008. Future CIPs will be influenced more heavily by the ATO as it participates in developing future Flight Plan goals and performance targets. These efforts will be translated into the service based capital improvement needs of the ATO and combined with the capital needs of existing FAA organizations outside the ATO.

The ATO has been established to more tightly focus FAA resources on improving the services it provides to aviation customers. Five operating service units are being established to reflect the direct services that allow aviation customers to fly safely in the National Airspace System. These operating units will have a clearly defined mission, a common set of goals and a consistent strategy that reflects the needs of customers. ATO leadership will have access to an information infrastructure that allows them to use accurate, timely data in their decision-making processes to improve air traffic control management and timely delivery of new technologies.

The five operating service units are:

- En Route and Oceanic - provides en route and oceanic services and the capabilities to support those services
- Terminal - provides terminal services and the capabilities to support those services
- Flight Services - provides overall flight planning and advisory services
- System Operations - provides national guidance and policy for air traffic procedures and airspace issues
- Technical Operations - provides maintenance, construction and navigation services to the ATO

These service units will have the authority, responsibility, and accountability for providing their designated services. Their responsibilities will also include:

- Planning for the future
- Developing requirements for equipment to support improved services
- Completing investment analyses on new equipment
- Developing and implementing new equipment and procedures
- Developing performance goals to measure quality of service
- Balancing improvements to service to meet internal and external goals

The operating service units have been established and the vice-presidents to run them have been chosen. They will establish performance metrics to measure their success and provide accountability to management and customers.

## **2 Other Planning Efforts Complement the CIP**

### **2.1 The FAA Aerospace Forecast Projects Future Workload**

The FAA Aerospace Forecast annually projects the level of aviation activity and FAA workload for the next 12 years. This forecast is key to the FAA system engineering efforts that develop the components of the NAS Architecture. The information enables the FAA to develop engineering designs that address anticipated overall growth and changes in the tempo of operations at key airports. The forecast also fosters design of new, larger systems that must accommodate future air travel demand and that deal with the complexities of increased levels of operations at the busiest airports.

Although growth of air travel is in a temporary decline, commercial air travel in the past 20 years has more than doubled. We expect this long-term growth trend to resume as the overall economy improves this year and next. The FAA expects air travel to reach the levels attained in 2000 within the next two or three years and then resume more normal growth rates.

It is important to remember that the high level of activity during 2000 often exceeded the capacity of the airport and airway system, resulting in congestion and delay. During the late 1990s and in 2000, the FAA was falling behind in our attempts to modernize the NAS. Simultaneously, we were providing new airspace capacity to handle the needs of the growing aviation industry. Because of the long lead times for implementing improvements, the CIP must plan for a substantial level of capital investment during the present slowdown in the industry. As demand builds, we will be able to reach and maintain the airspace capacity necessary to serve the growing aviation industry.

Several factors support the projections of continued growth in aviation. The general economy has begun to return to higher growth rates. Demand for leisure travel has increased because of increasing consumer preference for air travel, increasing disposable income, and lower relative fares. The globalization of industry continues leading to greater demand for business air travel. Use of regional jets for service to smaller markets has made air travel more available and appealing for people living in those communities, and the continuing success of low-cost service and falling real fares is generating increased demand. By 2006, both the total number of instrument flight rule (IFR) operations at towers and the number of IFR operations handled by en route centers is forecasted to return to and then exceed past peaks.

### **2.2 Concept of Operations Describes Future ATC Capabilities**

The FAA and the aviation industry jointly developed the RTCA NAS Concept of Operations and Vision for the Future of Aviation (Conops). The Conops details the consensus view of what air traffic control capabilities should be available in the future. This view sees a future air traffic control system that will allow all customers to operate without undue constraint in a system that enhances today's high level of safety while providing equitable access. The Conops is the starting point for determining the shape of

the system of the future. The operating capabilities outlined in the Conops become the conceptual framework for designing the systems and operating procedures that will be implemented over the next several years.

### **2.3 NAS Architecture and Target System Description detail NAS systems and services**

The NAS Architecture is a Web-based information system that describes the systems and services provided for the NAS. It starts by describing the key elements of the services provided to aviation customers and then translates that information into NAS systems and components. The NAS Architecture identifies the current capabilities and how they will evolve over the next 15 years to meet the future needs of the FAA and its customers. It also shows system and component cost and schedule. The NAS Architecture identifies the interactions between systems and serves as the basis for future capital investment.

To provide a view of the NAS Architecture at a specific point in time, the FAA has developed a Target System Description (TSD) to help define what actions need to occur between now and 2015 to satisfy customer concerns and accommodate aviation growth. The TSD sets a target for the system configuration in 2015, and it identifies the new component systems that must be developed to meet that target. By setting a goal for modernization at a specific point in time, the TSD promotes planning efforts to identify the specific steps necessary to reach that configuration by 2015, and it becomes a valuable vehicle for discussing with customers progress toward the system of the future. The TSD has been incorporated into the NAS Architecture.

Many of the projects and concepts developed to support the TSD and NAS Architecture will not be implemented until after 2009. Budget estimates in the CIP do not extend beyond 2009. However, the vision of the future contained in the NAS Architecture is used to supplement the discussion of current projects supporting the functional areas presented in following sections of the CIP. As with any plan, not every component will be implemented exactly as described in the NAS Architecture, but many of the TSD capabilities will be complete by 2015. The future vision defined in the NAS Architecture, including the TSD, helps shape financial planning for the CIP timeframe.

### **2.4 Capacity Plans Analyze NAS Issues**

The Airport Capacity Enhancement Plan (Capacity Plan) and the Operational Evolution Plan (OEP) are near to mid-term plans that address capacity issues in the NAS. Recommendations in the Capacity Plan and OEP help set priorities for projects in the CIP. These two plans analyze issues related to present operations and recommend near-term changes that will enhance capacity and improve NAS performance. These plans often include recommendations for specific CIP projects and implementation schedules that will yield capacity gains.



### **3 FAA Strategic Plan Identifies Missions and Goals**

#### **3.1 Government Performance and Results Act Requires a Performance Plan**

The Government Performance and Results Act (GPRA) of 1993 requires that all Federal agencies develop a strategic plan and a performance plan. These plans identify key agency missions and set goals for improving the outcomes of agency services. Agencies expend substantial effort in developing these plans, which OMB and the Congress use to judge whether or not Federal agencies are accomplishing their stated purposes. The OMB puts a high priority on developing strategic plans, and the President's Management Agenda includes a goal for improving the ties between an agency's performance goals and its budget.

The Flight Plan 2004-2008 is the FAA's new strategic plan. It contains the broad strategic goals that define the fundamental purposes of the agency. Under each of the broader goals is a list of objectives, strategies, and initiatives that articulate the actions the FAA believes are necessary to accomplish those goals. Each objective also has a measurable performance target. These targets set a specific level of achievement in a specific timeframe to meet the objectives.

Consistent with the President's Management Agenda, most of the capital investment projects in the CIP have been linked to a goal and objective. The list of goals, objectives, and the related projects appear in Appendix A. Because of the complexity of the NAS, there are normally several projects that are grouped under a single objective and its related performance targets. This is because the projects all contribute to that objective and its performance targets, and, in many cases, the projects are interdependent. Determining the contribution of each individual project to a performance target would require arbitrary allocation of benefits and would introduce a level of complexity that would detract from the focus on key agency goals and minimize the value of performance management. It is also important to note that some of the objectives are supported by operating and airport grant programs, and these objectives do not have corresponding capital investment projects.

#### **3.2 FAA Strategic Goals, Objectives, and Performance Targets**

The FAA strategic goals are:

- **Increased Safety:** Achieve the lowest possible accident rate and constantly improve safety.
- **Greater Capacity:** Work with local governments and airspace customers to provide capacity in the United States airspace system that meets projected demand in an environmentally sound manner.
- **International Leadership:** Increase the safety and capacity of the global civil aerospace system in an environmentally sound manner.

- **Organizational Excellence:** Ensure the success of the FAA's mission through stronger leadership, a better trained workforce, enhanced cost-control measures, and improved decision-making based on reliable data.

### **3.3 Additional Department of Transportation (DOT) Goals Relate to FAA Goals**

The DOT Strategic Plan contains goals for security and environmental stewardship. These goals apply to all DOT modes. The FAA has not explicitly included them in its Strategic Plan, but there are some projects that relate directly to these goals. The related DOT goals and objectives follow.

#### **3.3.1 Environmental Stewardship**

*Objective: Promote transportation solutions that enhance communities and protect the natural and built environment*

#### **3.3.2 Security**

*Objective: Balance homeland and national security transportation requirements with the mobility needs of the Nation for personal travel and commerce*

## **4 Capital Investment Projects and FAA's Vision for the Future**

This section highlights some of the major programs in the FAA's Capital Investment Plan (CIP), and the projects within these programs that form the core of FAA's modernization plans for the next five years. The CIP contains projects that are already under contract, as well as new initiatives. These projects support the FAA Flight Plan 2004-2008, and they, in some cases, are the prelude to completing the longer-term vision of the Target System Description.

### **4.1 Surface Radar Systems Increase Safety in Airport Operating Areas**

Surface radar systems support the safety initiatives described in the FAA Flight Plan to reduce runway incursions. To prevent accidents on airports runways and taxiways, air traffic controllers need to have precise information on the location of aircraft and other vehicles in the airport operating areas. These radars are especially valuable in decreased visibility conditions and in locations where tower controllers cannot see some segments of the runways and taxiways. In the near term, the FAA will complete installation of additional radars. In the intermediate term, the FAA will upgrade the software that provides automated warnings of potential runway incursions. For the longer term, the FAA will develop the capability to data-link displays of ground traffic information and a moving map of the airport surface to pilots in the cockpit.

#### 4.1.1 Runway Incursion Radars

To protect against runway incursions at busy airports that do not already have airport surface radars, the FAA is installing the Airport Surface Detection Equipment – Model X (ASDE-X). This system uses advanced technology to detect aircraft and ground vehicles in the airport operating area. In addition to the ASDE-X radar system that detects location of aircraft on the surface of an airport, advanced technology is used to pinpoint the exact position of aircraft and vehicles. We will deploy ASDE-X at 25 operational and four support sites.

The FAA has installed ASDE-Model 3 at more than 40 locations. This system provides controllers a radar display of aircraft and vehicles in the airport operating area during low-visibility conditions. The ASDE-3 is now enhanced with the Airport Movement Area Safety System, which gives automated runway incursion warnings. Controllers can use these systems to alert pilots and ground-vehicle operators that a runway incursion has occurred, so they can avoid accidents. Funding is requested to modernize these systems so that they continue to operate efficiently over the next ten years. In addition, the advanced technology that uses electronic aids to detect aircraft and ground vehicle location, developed in the ASDE-X program, will initially be added to seven of the ASDE-3 systems and is being considered for all ASDE-3s.

## 4.2 Aviation Safety Oversight Systems

There are about 20,000 aircraft in commercial service and over 200,000 in general aviation. The FAA has licensed more than 600,000 pilots and over 300,000 mechanics. Due to the large number of commercial and general aviation operators, aviation personnel, and repair facilities, the FAA needs automated tools to track their safety records and to ensure that they adhere to regulations and standards.

Aviation safety systems support safety regulation and monitoring programs by collecting data used to assist in:

- Issuing licenses and certificates to ensure that aviation personnel meet established qualifications and that manufacturing and repair facilities conform to standards for design and modification of aircraft
- Monitoring both the companies and the personnel that provide aviation services to ensure that safety is given the highest priority

In the near term, the FAA will continue developing computer databases that provide safety inspectors the information they need on FAA regulations, operating policies and procedures, and the historical safety and violation records of companies and aircraft they inspect. In the intermediate term, the FAA will enhance those computer systems by standardizing the architecture and adding more sophisticated communication links. For the longer term, the FAA will increase the processing power of the software to assist inspectors in analyzing information and targeting inspection efforts to focus on the most significant problem areas.

#### 4.2.1 Aviation Safety Analysis System

The Aviation Safety Analysis System supports a number of databases used in the safety program. The databases include records of licenses and certificates, violations of FAA regulations, and accident and incident data for individuals and airlines. These databases support analysis and enforcement activities of FAA safety inspectors and certification staff. Future plans call for modernizing the computer system architecture to ensure compatibility among the diverse databases and increase the number of ways the data can be accessed. Diversity in connecting to the databases needs to be improved to support inspectors who require access to the information from remote locations.

#### 4.2.2 Safety Management System

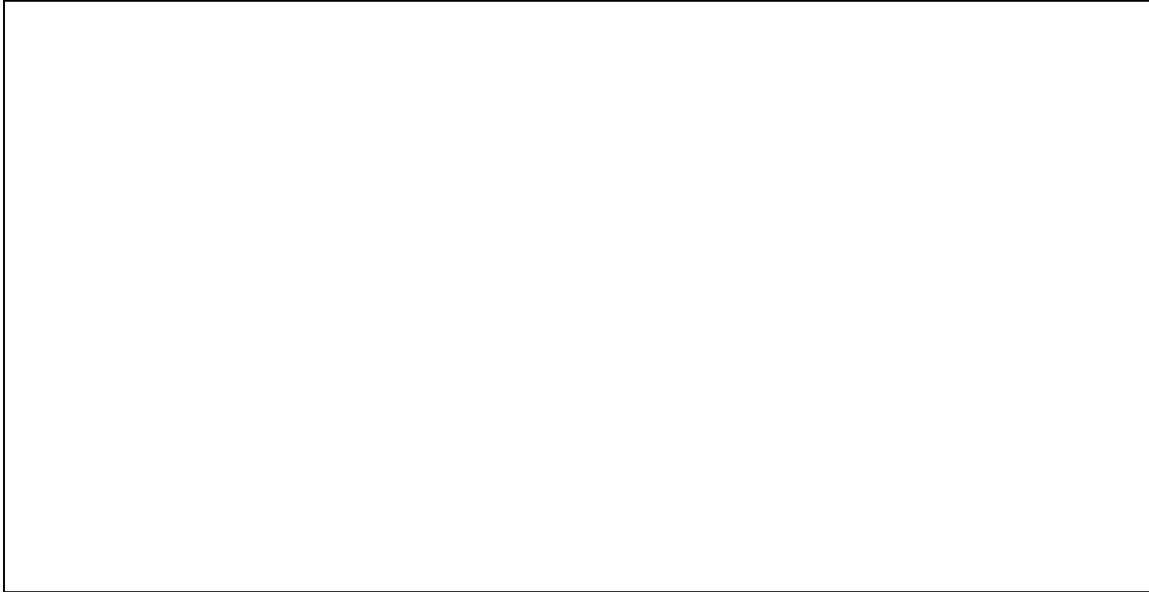
Consistent with International Civil Aviation Organization (ICAO) recommendations, the FAA is upgrading its capabilities for safety risk assessments. These assessments will apply to introduction of new and modified equipment, operational procedures associated with that new equipment, and airspace redesign to enhance capacity. These new efforts will organize existing processes to coordinate analysis of safety issues, and they will enhance the consistency of safety risk assessments. In addition, the FAA will ensure more rigorous documentation of safety assessments to make certain that future assessments can benefit from work previously done.

### 4.3 Automation Systems

Automation systems are central to modern air traffic control. They process data from radars and other computers to provide a continuous display of aircraft location and provide air speed and altitude information to the air traffic controller. Having this data on radar displays increases the number of aircraft a controller can safely handle. FAA facilities have used automation systems since the 1970s and must continually upgrade them. Work on the next round of upgrades is progressing and should be substantially completed in the CIP's five-year timeframe. In the mid and long term, the NAS Architecture proposes improving the information flow of air traffic information and merging some automation functions. This will increase air travel efficiency and allow transition to a standardized display system for both en route and terminal control facilities.

As shown in Figure 1, when aircraft proceed from takeoff to landing, three different facilities generally provided air traffic control. The airport traffic control tower directs traffic on the airport surface through takeoff. After the aircraft is in the air and about five miles from the airport, a terminal facility using radar control takes over. Normally, as the aircraft is climbing toward cruise altitude and is less than 30 miles from the airport, the terminal facility transfers control of the aircraft to an en route facility. En route control continues until the aircraft is about 30 miles from its destination airport, where it is handed off to a terminal facility again and then to an airport tower. Both terminal and en

route facilities use radar surveillance and automation systems to assist controllers in providing adequate separation between aircraft.



**Figure 1. Relationship of Tower, Terminal, and En Route Air Traffic Control**

#### 4.3.1 En Route Automation Systems

Currently, en route facilities handle about 44 million aircraft per year at 21 facilities. In ten years, this workload is forecast to grow about 25 percent. To accommodate that growth, the FAA must modernize its en route automation systems. In the near term, the FAA will continue to upgrade the existing en route automation systems by replacing peripheral components and the displays. During this period, the FAA will be planning and designing a replacement system that requires rewriting the software and installing new computers. The replacement is planned for about 2010. The new system will support added capabilities planned for the longer-term such as interactive flight planning, reduced horizontal separation for aircraft, and sharing of air traffic information for collaboration on strategies to decrease delays.

This replacement program, En Route Automation Modernization (ERAM), will modernize the en route environment and infrastructure to provide a modular, expandable, and supportable system. The major new elements ERAM will address are safety logic in the backup system, flexible routing, utilization of surveillance information, and the ability to integrate new capabilities without costly redesigns.

ERAM will replace the existing en route control automation system. A major component of the existing system is the Host Computer. It processes and formats flight plan and aircraft position information for display on the air traffic controller workstations. It also calculates the speed at which the aircraft is moving over the ground and can project the aircraft's position for a short time into the future. The basic software architecture of the

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Host Computer is over 30 years old, which is obsolete by modern engineering standards, and it is costly to maintain.

The current backup for the Host Computer is the Direct Access Radar Channel (DARC). This system lacks many of the Host's functions, and when this back up system is used during a Host failure, increased separation between aircraft is necessary which results in a reduction in airspace capacity. With ERAM, primary and backup systems will have the same capabilities and functions will be added to provide end-to-end flight routing across airspace boundaries.

The Peripheral Adapter Module Replacement Item (PAMRI) is another system that supports the Host Computer. The PAMRI receives data from the radars that determine aircraft position, flight plan data from computer tapes, and communications from other air traffic facilities and formats that information for the Host Computer. The FAA is replacing PAMRI with a new system called the En Route Communication Gateway (ECG) beginning in 2004 as part of the en route modernization program. The existing PAMRI needs replacing to remain compatible with Host Computer upgrades.

In addition to the computer systems and software, several outdated Host Computer peripherals need to be replaced. Over the next five years, the FAA will be replacing obsolete and worn-out storage devices, printers, and other input/output devices used with the Host Computer. The new peripherals have more capacity and are more efficient to operate.

As we approach the 2015 timeframe, efforts to standardize the platforms used in en route and terminal systems will be part of the engineering design.

#### 4.3.2 Terminal Automation

Terminal air traffic control facilities handle about 50 million instrument operations at airports per year, and that number is expected to increase by about 20 percent over the next 10 years. Given that travel demand tends to concentrate service at the busiest airports, and that there are constraints on building new runways, this amount of growth will require more sophisticated automation tools to sustain airport capacity during periods when adverse weather currently causes a reduction in the capacity available under Visual Flight Rules (VFR) conditions. Upgraded terminal automation systems will expand the capacity to accommodate aviation growth at airports.

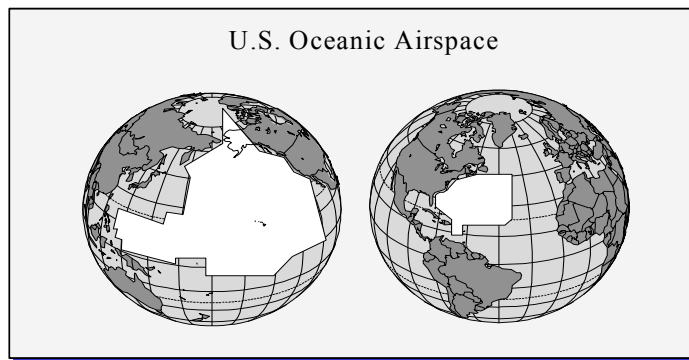
In the near term, the FAA is replacing the existing terminal automation systems with the Standard Terminal Automation Replacement System (STARS). Replacement will take place over several years. These new systems will be able to handle new automation tools that will maximize use of available runway capacity. These tools, coupled with new traffic management tools discussed in paragraph 4.7.2, will improve efficiency of operations at major airports and complement the new capabilities provided by the en route automation modernization program. By 2015, the FAA will be developing a

standardized platform for en route and terminal systems and better integrating the functionality between the two systems.

To date, the FAA has deployed 13 systems, including the first two key sites at Syracuse, New York, and El Paso, Texas, and a fully operational system at Philadelphia. We will be installing the remaining STARS systems with all planned features over the next several years.

#### 4.3.3 Oceanic Automation

The FAA controls traffic over a large part of the North Pacific and about half of the North Atlantic, shown as the white areas in Figure 2. Radar surveillance is not available in the majority of oceanic airspace, and this currently means that aircraft may be required to maintain separation up to 100 miles to ensure safe flight. With the implementation of new technology, we will be able to reduce separation of aircraft on oceanic flights using automatic dependent surveillance and satellite communication links coupled with a system that provides a computer display of oceanic traffic. With demand for international travel growing faster than demand for domestic travel, aircraft currently cannot always be assigned the altitude or route that is either the most fuel efficient or shortest duration during oceanic travel. By reducing separation in oceanic travel, controllers can assign more aircraft to preferred altitudes and routes. The new automation systems are scheduled to be operational at the three oceanic control centers (Oakland, New York, and Anchorage) beginning in 2004.



**Figure 2. U.S. Oceanic Airspace**

#### 4.4 En Route and Terminal Surveillance Systems Improve ATC Efficiency

Surveillance systems significantly improve the efficiency of air traffic control. When air traffic controllers have a precise image of aircraft position, they can safely use reduced separation between aircraft. Ground-based radars currently provide the majority of surveillance information. Primary radars provide aircraft location information by transmitting a radar signal and then detecting the reflected energy from the surface of the aircraft. Secondary radars transmit a signal, which triggers a transponder in the aircraft to reply with altitude information and a code that identifies the aircraft. This system also

measures the location of the signal to determine aircraft location. The FAA has replaced a portion of the primary and secondary terminal radars in use and will be replacing the remainder over the next several years.

In the near term, the FAA will focus on replacing older systems. For the future as outlined in the NAS Architecture, the FAA is planning to supplement the ground-based radars with a system that reports aircraft location to FAA air traffic facilities by using a satellite-based communication link and the onboard navigation systems in the aircraft. This is called Automatic Dependent Surveillance-Broadcast (ADS-B), and it is in limited use in a few air traffic control facilities. By using multiple sources of location information, controllers can provide reduced separation and accommodate a larger number of aircraft in any given segment of airspace.

#### 4.4.1 Terminal Surveillance

Several projects are underway to replace the surveillance radars and beacon interrogators (secondary radars) that provide position information to controllers. The Airport Surveillance Radar – Model 11 (ASR-11), which has a digital output, will replace ASR-8 and earlier model analog radars. The FAA has already replaced about half of the terminal radars with the Airport Surveillance Radar – Model 9 (ASR-9), which is also a digital radar. The ASR-11 program will replace all older surveillance radars but the ASR-9s, consistent with plans to renovate the existing ASR-9s, to extend their life. The ASR-11 transmits data in a digital format, because the new terminal automation systems called STARS require digital information. The FAA is replacing older Air Traffic Control Beacon Interrogators (ATCBI) with the new ATCBI-6. The FAA has previously replaced the older terminal ATCBI systems with a system known as Mode-S, and the older en route ATCBI systems are now being replaced with ATCBI-6.

#### 4.4.2 New Technology to Improve Safety

In addition to supplementing existing radars to allow reduced separation between aircraft, the automatic dependent surveillance system can help prevent accidents. There have been several fatal aviation accidents involving controlled flight into terrain due to poor awareness of terrain hazards near the route of flight. The Safe Flight 21 Capstone program in Alaska is working with the aviation community to evaluate the benefits of providing additional information to pilots through an affordable terrain database and display. Use of this database coupled with use of Global Positioning System (GPS) navigation capability and the Wide Area Augmentation System can warn pilots about high terrain near the flight path of the aircraft.

### 4.5 Navigation Systems Define ATC Route Structure

Most current navigation aids are ground based. One of the most important systems from an air traffic control perspective is the network of about 1,000 very high frequency omnidirectional range (VOR) aids to navigation that define the route structure. In addition, there are about 1,000 instrument landing systems (ILS) that provide pilots precision



guidance for low-visibility approaches to airports. These systems will remain as the primary navigation aids in the near term. In the intermediate and far term, there will be a partial transition to satellite navigation systems with augmentation.

#### 4.5.1 Sustaining Existing Navigation Systems

There will be a continuing need to sustain existing navigation systems. After the partial transition to augmented satellite navigation systems, the FAA will maintain a minimum number of existing systems to backup the new services. In addition, there will be a short-term demand for new ILSs. As new runways are built at larger airports and other locations qualify for an ILS, they will be installed. Several other CIP projects are necessary to support these new installations. An ILS requires one or more runway visual range sensors to report runway visibility to pilots and controllers. Precision approaches also require approach lights for the runway to help the pilot see the runway while the aircraft descends to the minimum altitude allowed. A minimum system of VOR aids will require renovation. In addition such services as weather broadcasts on the VOR frequency of stations that are eliminated will have to be hosted on other systems.

#### 4.5.2 Satellite Navigation

Global Positioning System (GPS) satellite navigation augmented with the Wide Area Augmentation System is a very accurate system that can provide substantial benefits to pilots. It will allow pilots with properly equipped aircraft the opportunity to fly direct routes using a technique called area navigation (RNAV). The advantage of RNAV is that pilots can request direct routes between geographic points rather than using the current airways which are based on flying between radio navigation aids. This can save both time and distance. The FAA commissioned the Wide Area Augmentation System in July 2003.

#### 4.5.3 Transition to Navigation System of the Future

Planning is underway to determine how to integrate expanded navigation services into the National Airspace System. Detailed studies are in progress to determine the optimal mix of current systems and augmented satellite navigation systems. The FAA anticipates that augmented satellite navigation will replace a portion of existing systems, including the instrument landing systems that provide precision guidance to runways. A transition of this magnitude will require equipment and procedure changes to take advantage of the increased capabilities of these new systems. It may require or allow redesign of the airspace that is based on existing navigation aids.

### 4.6 Communication Systems Increase Capacity

As the number of aircraft using air traffic control services increases, the radio frequencies used by controllers for communication with pilots become more congested. To ensure enough capacity to handle future demand, we must upgrade the radios used by

controllers. In addition, the introduction of data-link communications can improve efficiency and provide more comprehensive information to the cockpit.

In the near term, capital investment will support renovation and expansion of current systems plus the beginning phase of a transition to a more capable future system. The FAA must replace a limited number of existing and backup systems each year. There is also a need to relocate remote communication sites as airspace is changed to reflect new traffic patterns. In the intermediate term, the FAA is planning a transition to the next generation communication system that effectively provides additional frequencies and a data-link capability. The long-term improvements will introduce more systematic use of data link to support many of the planned efficiencies provided by other programs.

#### 4.6.1 Sustaining the Existing Systems

There are about 3,000 remote communication facilities that enable controllers and flight service specialists to talk to pilots that would otherwise be out of range of their radios. These remote facilities receive the radio transmissions from pilots and transfer them to FAA facilities on telephone lines. In addition, there are backup communication sites that allow contact with pilots, if the primary sites fail. Until the FAA replaces this equipment, the Agency must renovate it.

In addition, airspace changes to accommodate changes in flight patterns often require that these facilities be relocated to ensure radio contact can be maintained. Investment for this purpose will continue after a transition to new radio technology.

#### 4.6.2 The Next Generation Radio Communication (NEXCOM) System

The Next Generation Communication System (NEXCOM) uses digital technology and increases the number of channels per existing assigned frequency to provide more capacity. The NEXCOM uses the radio frequencies assigned to the FAA, but it increases the capacity of these frequencies up to four times. Using a technology that allows four separate channels on one frequency, NEXCOM will increase the voice channels for communication between pilots and controllers and enable one of the new channels to support data link communications. The switch to digital technology will also provide technical advantages over the existing analog technology. We will implement NEXCOM incrementally, switching to digital radios over the next several years and adding enhancements during and after transition.

#### 4.6.3 Data Link Systems

Data-link technology allows facilities on the ground to transmit text messages and, in some applications, graphics to aircraft in flight. The Aeronautical Data Link program is developing a data-link system for text messages. The system can provide controllers and pilots an alternate automated communications path separate from the voice radio communications path, which can become congested in busy terminal areas. Data-link also allows the pilot to save the message and check it as necessary. Currently, flight-plan

clearances are being transmitted from air traffic control facilities to pilots by data-link at 29 airports. The Controller Pilot Data Link Communication (CPDLC) system is in operation at the Miami en route control center, and it is being used to test operational procedures to be used if the system is implemented at additional locations.

Graphics messages on data link can include weather maps and forecasts and displays of nearby air traffic. They will help pilots make more informed decisions. Two key issues in implementing data link are: (1) to ensure that the message being transmitted is not altered or truncated in transit and (2) to assure both the pilots and controllers that the source of the message is legitimate. Many of the service improvements planned for the NAS Architecture will rely on using data link to share airspace status information and help pilots plan for less restricted routes of travel.

#### **4.7 Traffic Flow Management: A Source of Air Traffic Efficiencies**

Many of the efficiencies in handling air traffic result from improvements in air traffic management. Using predictive software, the FAA can forecast traffic demand throughout the system and take actions to minimize delays caused by adverse weather or localized system problems. The Air Traffic Control System Command Center coordinates with traffic management units in larger air traffic facilities to manage traffic flows to match capacity and prevent delays. In the en route phase of flight, controllers use automation software to provide more efficient routing.

##### **4.7.1 Free Flight Phase 2 Implementation**

During the Free Flight Phase 1 program, the FAA installed the Traffic Management Advisor (TMA) in seven en route centers. This automation system has increased the average number of aircraft handled during peak hours at an airport within the range of 3 to 5 percent, which can significantly reduce delays. Free Flight Phase 2 installed TMA at Jacksonville, Florida in FY 2003, and it will install TMA at two additional centers.

The FAA will be using the User Request Evaluation Tool (URET) at ten en route centers by the end of FY 2004. We will begin use of the tools at seven additional centers in FY 2005, and we will complete installations in FY 2006. The URET allows an air traffic controller to project an aircraft's flight route into the future and determine whether a change in route will create conflicts with other traffic. Using this information, a controller can approve more direct routing as requested by pilots, which normally saves flight time and fuel. Free Flight Phase 2 will also sustain and improve Collaborative Decision Making tools that we use to communicate with airline operations centers. This allows us to collaborate with customers to determine the best way to manage potential delays due to adverse weather or other airspace congestion problems.

##### **4.7.2 Air Traffic Management**

In addition to the Free Flight Phases 1 and 2 automation aids, the FAA is using several other software automation aids at en route centers and towers. These national-scale

management tools balance traffic loads and maximize air traffic flow within the constraints of the national airspace. The automation tools developed for the air traffic management program, coupled with the tools deployed by the Free Flight program, reduce delays and increase our ability to accommodate arriving aircraft by 5 percent. We must replace the software and hardware that support these tools to improve the efficiency of the computer systems that we use for air traffic management. Modernizing this infrastructure will also enable continued development of products and services to more effectively manage the flow of air traffic.

#### 4.7.3 Air Traffic Control System Command Center

The Air Traffic Control System Command Center (Command Center) located at Herndon, Virginia tracks all air traffic in the United States and uses sophisticated software tools to predict problems or delays in the system. These tools support collaborative decision-making between the FAA and airline operations centers. We will make enhancements to the Flight Schedule Monitor, Post Operations Evaluation Tool, and the Route Management Tool to improve the effectiveness of this existing software.

After collaborating with commercial customers, the Command Center can coordinate with FAA field facilities to select the best strategies for regulating traffic flows in the system to prevent large hub airports from being saturated with more traffic than the airport can handle. We must also coordinate with the Department of Defense and international air traffic control facilities when military operations or international traffic are expected to impact operational flows.

#### 4.7.4 Next Generation Traffic Flow Management

The NAS Architecture envisions an enhanced decision support system to provide increased information exchange between service providers and FAA customers via System Wide Information Management (SWIM). This would include exchanges of changes in routing, weather or congestion to permit increased collaboration with external customers. The Next-Generation Traffic Flow Management also provides for real time and post-event analysis, increases predictability of system operation and manages pre and post-flight information.

### 4.8 Weather Sensing and Display Systems Provide Accurate Information

Accurate information on weather is essential to both the safety and efficiency of flight. Pilots request routes that allow them to avoid hazardous weather. Winds at flight altitudes can significantly affect the speed of travel, and pilots try to take advantage of favorable winds and minimize the impact of unfavorable winds. Improvements to weather reporting and forecasting provide significant benefits.

In the near term, the FAA will upgrade the Weather and Radar Processing System that provides weather data to the en route centers. In the intermediate term, the FAA will implement improved weather products that provide more precise estimates of the location

of weather hazards and the intensity of meteorological events. It is anticipated that commercial sources may also offer data-link weather information to pilots. For the longer term, FAA is working on a new en route weather reporting and display system that will collect data from more sources and provide more accurate predictive information on the future weather.

#### 4.8.1 Improved Weather Information for En Route Facilities

Accurately depicting and forecasting weather is key to increasing efficiency of air traffic control. The Weather and Radar Processor (WARP) provides timely weather radar information to the controllers, traffic management specialists, and the Center Weather Service Unit meteorologists at the en route centers. In addition the Corridor Weather Integrated System, developed in conjunction with the Integrated Terminal Weather System program, provides a display of weather along heavily traveled routes. Controllers use this information to advise pilots of the routes least affected by weather, and air traffic flow managers use it to decide how to apply advanced air traffic management tools. Having better information about the weather and a shared situational awareness, center air traffic controllers can improve the efficiency of traffic flows and minimize delays caused by having to avoid bad weather. We will upgrade WARP to be compatible with the upgraded weather radars operated by the National Weather Service, add software products developed by the weather research program, and start work on developing a more capable future system. The equipment is installed at all the en route centers.

#### 4.8.2 Wind Shear Detection systems

The FAA has installed Terminal Doppler Weather Radars (TDWR) at 45 large airports with the highest wind shear risk. The TDWR displays show areas of wind shear and gust fronts, which enable tower controllers to warn pilots of existing wind shear conditions. The existing TDWR systems have had maintenance problems, and we need to invest capital in a service life extension program to ensure that these vital safety systems operate reliably through 2020.

#### 4.8.3 Future Improvements in Weather Systems

The NAS Architecture contains plans for a comprehensive weather information system that will improve the real-time transfer of weather information to pilots and controllers. Both text information and weather graphics will be available and can be displayed on a color display in the cockpit, as well as on the controller's display, to assist pilots in choosing a route of flight to avoid severe weather problems.

### **4.9 Infrastructure Replacement: Modernization of the NAS**

The FAA has several billion dollars worth of installed infrastructure to support air traffic control and other services. The infrastructure includes buildings to house air traffic control automation, communication, surveillance, and navigation equipment and electrical power systems, and connecting communication infrastructure. These buildings

and related infrastructure require modernization and periodic replacement. Replacing deteriorated facilities and adding more modern infrastructure reduces outages and prevents delays. Modernization also keeps the FAA abreast of changes in aviation technology.

Efforts in this area will continue through and beyond 2015. One major impact of implementing the NAS Architecture will be the need to build new facilities to house new equipment. New equipment and capabilities often require more space than is available in existing facilities. Relocating equipment also often requires additional investment in infrastructure.

#### 4.9.1 En Route Facilities

The Air Route Traffic Control Centers house the en route centers, and modernization is ongoing to keep these facilities in good operating condition and to accommodate growth in workload. We must maintain roofs, update electrical wiring as new equipment is installed, and upgrade the heating and ventilating systems to protect the sensitive electronic equipment housed in the centers. This program is essential for NAS modernization, and we must sustain it well into the future.

#### 4.9.2 Terminal Facilities

The towers and terminal radar control (TRACON) facilities that control traffic in the areas near airports require modernization for a number of reasons. In some cases, new airport construction has restricted visibility of the runways and taxiways; thus, the towers need to be higher so that controllers can clearly see the airport operating area. In other cases, the facility is too small for installation of new automation equipment. Also, existing facilities are old and deteriorating. FAA has over 400 FAA and contract air traffic control towers, and, as towers age, they require new infrastructure or replacement. FAA replaces about 5-10 towers per year and will continue replacing or modernizing towers well into the future.

#### 4.9.3 Unmanned Facilities

The FAA must maintain the permanent buildings that house thousands of remote radios, navigational aids, and radars used for air traffic control to prevent damage to the electronic equipment. Failure of this equipment can cause air traffic delays; therefore, it is crucial that the FAA maintains and modernizes these buildings to ensure continued and reliable operation of the equipment inside.

#### 4.9.4 Voice Switches

Controllers must communicate with other air traffic control facilities either by voice radio or through automation-system-generated messages. A communications switch that serves the entire facility transfers these messages from the telephone lines to the controllers. We must modernize these switches to take advantage of improvements in technology and to

provide more efficient service. We are replacing 10 to 20 voice switches annually at towers and TRACON facilities and will continue to do so until the voice switches have been modernized.

The large voice switches at the en route centers have aging components, and the FAA is beginning engineering work on a program to replace these switches. The current switches were installed under the Voice Switching and Control System program. In the near term, the FAA is performing a service life extension program, which includes replacing the voice switch control units at all the en route facilities. We must make substantial future investment in voice switches to modernize and eventually replace these switches.

#### 4.9.5 Electrical Power Systems

Many FAA facilities have electrical generators and large battery banks that ensure continuity of electrical power during commercial power outages. The air traffic control system requires these backup systems to maintain reliability and to minimize disruptions to air traffic. When complete electrical outages occur, aircraft are separated manually, which is very inefficient and severely restricts capacity. The existing emergency generators are very old, and, in many cases, the manufacturers have gone out of business. We must replace these systems to preserve reliability of the air traffic control facilities.

### 4.10 Improved Management Tools Accommodate Expansion

Some CIP projects are directed at helping the FAA manage capital investment more efficiently. Improved management requires adoption of best business practices; improvements in information technology systems to automate cost and schedule estimates; automation of engineering design; and support from external contractors. As with private industry, we have benefited from using computer-aided design tools. Contractors also provide expertise in developing specifications and documentation of building and equipment configurations. This has helped us manage the large base of high-technology equipment that comprises the air traffic control system. Other examples of improved management tools are:

#### 4.10.1 NAS Infrastructure Management System (NIMS)

The NIMS program moves toward centralizing management of FAA's maintenance functions and develops the infrastructure for remote monitoring of the operational status of FAA's equipment. Growth in the number and sophistication of FAA facilities has led the FAA to find more efficient ways to maintain all new equipment. We manage our maintenance from a National Operations Control Center and three regional Operational Control Centers. Newer FAA equipment has remote maintenance monitoring built in, and the remote facilities transmit system status data to centralized maintenance management facilities. The regional maintenance centers can then send field technicians to repair outages or take preventative measures when the information transmitted indicates that performance has deteriorated. This reduces the number of technicians at remote locations and allows us to use them more efficiently.

#### 4.10.2 FAA Telecommunications Infrastructure

Communication is an integral part of air traffic control. The FAA needs an efficient and modern telecommunications system both to perform its air traffic functions and to manage our many dispersed facilities. We have contracted with a major telecommunications provider to support communications among the facilities. This new approach will be more efficient than the existing system and provide us with more software tools to measure communications use and allocate the costs to organizations more accurately.

#### 4.11 Protect FAA's Critical Infrastructure

Executive Orders have reinforced the need and stiffened the guiding principles for protecting the critical infrastructure of the United States. The air traffic control system is part of this critical infrastructure. The FAA has two major programs to protect infrastructure: one protects facilities and employees from physical threats; the other protects air traffic control information technology systems.

In the near- and longer term, the need to enhance security will continue. The most immediate steps are to improve security for manned facilities and to protect critical information- technology systems. We are resolving initial shortcomings while working to keep up with predicted threats and advances in detection technology to block sophisticated electronic intruders.

##### 4.11.1 Facility Security Risk Management

The first step in Facility Security Risk Management is to assess FAA's facilities to determine their vulnerabilities and compliance with Department of Justice security standards. We certify buildings when they are in compliance with standards and bring buildings needing additional security measures into compliance. We have developed a prioritized listing of our staffed facilities to identify modifications, procedures, and measures to enhance the security and safety of FAA personnel and facilities. Security systems include surveillance systems, intrusion detection systems, and access control systems.

##### 4.11.2 Information Security

In the past, many air traffic control automation systems were closed systems with proprietary software. These systems were very resistant to unauthorized entry. In modernizing its automation systems, the FAA has incorporated more commercial software, which creates a new vulnerability. We are assessing the vulnerabilities of all our critical systems and determining what protections we must add to prevent unauthorized access and disruption of the air traffic control system. We must also use an intrusion detection system so that we are aware of any efforts, successful or not, to gain access to our information-technology systems. Improving information security will be a growing expense for many years into the future.



## **5 Conclusion**

There are several important reasons for preparing the 5-year CIP in addition to the legislative mandate. Given the challenges of dealing with growth and changes in technology, the FAA must look to the future to ensure that we are addressing capacity and reliability issues. If we do not plan for the system of the future, we will not be able to accommodate predicted travel demand, and NAS performance will deteriorate. The high standards of performance for FAA equipment and automation systems require lengthy testing and implementation schedules. We must plan now for modernization to ensure that new equipment can be installed and operational in time to be ready for the future.

To facilitate decisions on the system of the future, the FAA has developed the Target System Description (TSD) as part of the NAS Architecture. The TSD establishes a benchmark for the structure of the air traffic control system in 2015. This provides the longer-range target for planning and the basis for an estimate of the resources to meet that vision of the future. Our partners in the aviation world are also interested in the structure of the future system, and they are recommending technology change and improved operating procedures. These changes require resources, and we must articulate the need for system improvements in the CIP and the TSD. The CIP provides visibility into the scope and planned schedule for capital expenditures planned for the next 5 years. This information allows an informed dialogue on the pace and content of our near term modernization efforts

## **6 Appendices to the Capital Investment Plan**

The CIP contains four appendices:

### **Appendix A**

- Lists FAA strategic goals, objectives, and performance targets
- Associates CIP projects with strategic objectives and performance targets

### **Appendix B**

- Lists CIP projects with over \$5 million in annual expenditures
- Provides description of project and relationship of project to strategic goals
- Lists FY 2003 Program accomplishments
- Lists FY 2004 Output goals
- Lists FY 2005 Output goals
- Lists key events 2006–2009

### **Appendix C**

- Provides estimated expenditures 2005–2009 by Budget Line Item

### **Appendix D**

- Defines acronyms